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**UTILITY PATENT APPLICATION TRANSMITTAL**

(Only for new non-provisional applications under 37 CFR 1.53(b))

Attorney Docket No. 42390.P8795Total Pages 2First Named Inventor or Application Identifier Reed J. SlossExpress Mail Label No. EL034159856US

**ADDRESS TO:** Assistant Commissioner for Patents  
 Box Patent Application  
 Washington, D. C. 20231

**APPLICATION ELEMENTS**

See MPEP chapter 600 concerning utility patent application contents.

1.  Fee Transmittal Form  
(Submit an original, and a duplicate for fee processing)
2.  Specification (Total Pages 25)  
(preferred arrangement set forth below)
  - Descriptive Title of the Invention
  - Cross References to Related Applications
  - Statement Regarding Fed sponsored R & D
  - Reference to Microfiche Appendix
  - Background of the Invention
  - Brief Summary of the Invention
  - Brief Description of the Drawings (if filed)
  - Detailed Description
  - Claims
  - Abstract of the Disclosure
3.  Drawings(s) (35 USC 113) (Total Sheets 7)
4.  Oath or Declaration (Total Pages 5)
  - a.  Newly Executed (Original or Copy)
  - b.  Copy from a Prior Application (37 CFR 1.63(d))  
(for Continuation/Divisional with Box 17 completed) (**Note Box 5 below**)
  - i.  DELETIONS OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
5.  Incorporation By Reference (useable if Box 4b is checked)  
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6.  Microfiche Computer Program (Appendix)
7.  Nucleotide and/or Amino Acid Sequence Submission

(if applicable, all necessary)

- a. \_\_\_\_\_ Computer Readable Copy
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#### ACCOMPANYING APPLICATION PARTS

- 8.  Assignment Papers (cover sheet & documents(s))
- 9. \_\_\_\_\_ a. 37 CFR 3.73(b) Statement (where there is an assignee)
  - \_\_\_\_\_ b. Power of Attorney
- 10. \_\_\_\_\_ English Translation Document (if applicable)
- 11. \_\_\_\_\_ a. Information Disclosure Statement (IDS)/PTO-1449
  - \_\_\_\_\_ b. Copies of IDS Citations
- 12. \_\_\_\_\_ Preliminary Amendment
- 13.  Return Receipt Postcard (MPEP 503) (Should be specifically itemized)
- 14. \_\_\_\_\_ a. Small Entity Statement(s)
  - \_\_\_\_\_ b. Statement filed in prior application, Status still proper and desired
- 15. \_\_\_\_\_ Certified Copy of Priority Document(s) (if foreign priority is claimed)

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*Patent*

UNITED STATES PATENT APPLICATION

for

SYSTEM AND METHOD FOR  
FAULT TOLERANT STREAM SPLITTING

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# SYSTEM AND METHOD FOR FAULT TOLERANT STREAM SPLITTING

## BACKGROUND OF THE INVENTION

### Field of the Invention

5 This invention relates generally to the field of network services. More particularly, the invention relates to an improved architecture for providing fault tolerant data communication.

### Description of the Related Art

As is known in the art, streaming is a mechanism for playing back audio and/or video content over a network in real-time, typically used in situations where network bandwidth is limited. The basic streaming concept is that the destination (e.g., a client) begins to play back the underlying streaming file from a buffer before the entire file has been received from its source.

A traditional network streaming system is illustrated in **Figure 1**. As shown, one or more clients 150, 160, configured with streaming application software such as RealPlayer® from RealNetworks® or Windows Media® Player from Microsoft® Corporation, communicate with one or more streaming servers 110, 111, . . . N, over a network 100 (e.g., the Internet). The group of streaming servers 110, 111, . . . N, are located together at a point of presence (“POP”) site. Each of the streaming servers 110, 111, . . . N, may store a copy of the same streaming data or, alternatively, may store different streaming data, depending on the configuration at the POP site 130.

In operation, when a client 150 requests a particular streaming file from a server at the POP site 120, the request is received by a load balancer module 120, which routes the request to an appropriate streaming server 111. Which server is “appropriate” may depend on where the requested file is stored, the load on each server 110, 111, . . . N, and/or the type of streaming file requested by the client (e.g., Windows Media format or RealPlayer format). Once the file has been identified by the load balancer 120 on an appropriate server – server 111 in the illustrated example – it is streamed to the requesting client 150 (represented by stream 140) through the network 100.

## BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the present invention can be obtained from the following detailed description in conjunction with the following drawings, in which:

5       **FIG. 1** illustrates a prior art system and method for streaming content over a network.

**FIG. 2** illustrates an exemplary network architecture including elements of the invention.

10      **FIG. 3** illustrates an exemplary computer architecture including elements of the invention.

**FIG. 4** illustrates various streaming sources supported by one embodiment of the invention.

**FIG. 5** illustrates stream splitting implemented in one embodiment of the invention.

15      **FIG. 6** illustrates a system for implementing a backup root splitter according to one embodiment of the invention.

**FIG. 7** illustrates a method for implementing a backup root splitter according to one embodiment of the invention.

## DETAILED DESCRIPTION

In the following description, for the purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be apparent, however, to one skilled in the art that the 5 present invention may be practiced without some of these specific details. In other instances, well-known structures and devices are shown in block diagram form to avoid obscuring the underlying principles of the invention.

### AN EXEMPLARY NETWORK ARCHITECTURE

Elements of the present invention may be included within a multi-tiered 10 networking architecture 200 such as that illustrated in **Figure 2**, which includes one or more data centers 220-222, a plurality of “intermediate” Point of Presence (“POP”) nodes 230-234 (also referred to herein as “Private Network Access Points,” or “P-NAPs”), and a plurality of “edge” POP nodes 240-245 (also referred to herein as “Internet Service Provider Co-Location” sites or “ISP Co- 15 Lo” sites).

According to the embodiment depicted in **Figure 2**, each of the data centers 220-222, intermediate POPs 230-234 and/or edge POPs 240-245 are comprised of groups of network servers on which various types of network content may be stored and transmitted to end users 250, including, for example, 20 Web pages, network news data, e-mail data, File Transfer Protocol (“FTP”) files, and live & on-demand multimedia streaming files. It should be noted, however,

that the underlying principles of the invention may be practiced using a variety of different types of network content.

The servers located at the data centers 220-222 and POPs 230-234; 240-245  
may communicate with one another and with end users 150 using a variety of  
5 communication channels, including, for example, Digital Signal ("DS") channels  
(e.g., DS-3/T-3, DS-1/T1), Synchronous Optical Network ("SONET") channels  
(e.g., OC-3/STS-3), Integrated Services Digital Network ("ISDN") channels,  
Digital Subscriber Line ("DSL") channels, cable modem channels and a variety of  
wireless communication channels including satellite broadcast and cellular.  
  
10 In addition, various networking protocols may be used to implement  
aspects of the system including, for example, the Asynchronous Transfer Mode  
("ATM"), Ethernet, and Token Ring (at the data-link level); as well as  
Transmission Control Protocol/Internet Protocol ("TCP/IP"), Internetwork  
Packet Exchange ("IPX"), AppleTalk and DECnet (at the network/transport  
15 level). It should be noted, however, that the principles of the invention are not  
limited to any particular communication channel or protocol.

In one embodiment, a database for storing information relating to  
distributed network content is maintained on servers at the data centers 220-222  
(and possibly also at the POP nodes 230-234; 240-245). This information may  
20 include the different POP sites which currently contain a copy of network

content. The database in one embodiment is a distributed database (i.e., spread across multiple servers) and may run an instance of a Relational Database Management System (RDBMS), such as Microsoft™ SQL-Server, Oracle™ or the like.

5

## AN EXEMPLARY COMPUTER ARCHITECTURE

Having briefly described an exemplary network architecture which employs various elements of the present invention, a computer system 300 representing exemplary clients and servers for implementing elements of the present invention will now be described with reference to **Figure 3**.

10

One embodiment of computer system 300 comprises a system bus 320 for communicating information, and a processor 310 coupled to bus 320 for processing information. The computer system 300 further comprises a random access memory (RAM) or other dynamic storage device 325 (referred to herein as "main memory"), coupled to bus 320 for storing information and instructions to be executed by processor 310. Main memory 325 also may be used for storing temporary variables or other intermediate information during execution of instructions by processor 310. Computer system 300 also may include a read only memory ("ROM") and/or other static storage device 326 coupled to bus 320 for storing static information and instructions used by processor 310.

A data storage device 327 such as a magnetic disk or optical disc and its corresponding drive may also be coupled to computer system 300 for storing information and instructions. The computer system 300 can also be coupled to a second I/O bus 350 via an I/O interface 330. A plurality of I/O devices may be 5 coupled to I/O bus 350, including a display device 343, and/or an input device (e.g., an alphanumeric input device 342 and/or a cursor control device 341).

The communication device 340 is used for accessing other computers (servers or clients) via a network 100. The communication device 340 may comprise a modem, a network interface card, or other well known interface 10 device, such as those used for coupling to Ethernet, token ring, or other types of computer networks.

## EMBODIMENTS OF THE INVENTION

### *Stream Splitting*

15 Embodiments of a system configured to stream live and on-demand audio/video content will now be described with respect to **Figures 4 and 5**. As shown in **Figure 4**, one embodiment receives and processes incoming audio/video content from a variety of sources including, but not limited to, live or recorded signals 401 broadcast over satellite links 410; live signals 402 provided via video conferencing systems 411; and/or live or recorded signals 20 403 transmitted over dedicated Internet Protocol (“IP”) links 412. It should be noted, however, that a various other network protocols (i.e., other than IP) may

be employed while still complying with the underlying principles of the invention. In one embodiment, each of the modules illustrated in **Figure 4** reside at a data center 220.

- System acquisition and management modules (“SAMs”) 420 open and
- 5 close communication sessions between the various sources 401-403 as required. For example, when a content provider wants to establish a new live streaming session, the SAM 420 will open a new connection to handle the incoming audio/video data (e.g., after determining that the content provider has the right to establish the connection).
- 10 The SAM module 420 will handle incoming signals differently based on whether the signals have already been encoded (e.g., by the content providers) and/or based on whether the signals are comprised of “live” or “on demand” content. For example, if a signal has not already been encoded by a content provider (e.g., the signal may be received at the data center 220 in an analog format or in a non-streaming digital format), the SAM module 420 will direct the signal to one or more streaming encoder modules 1430, which will encode the stream in a specified digital streaming format (e.g., Windows Media® format, Real G2™ format, . . . etc.).
- 15

If the incoming signal is live, the streaming encoders 430 transmit the  
20 encoded signal directly to one or more streaming origin servers 510 (which

distribute the signal to various POP nodes as described below) and/or to one or more content storage devices 431 at the data center 220. If, however, the

incoming signal is an on-demand signal (i.e., to be stored and viewed by clients at any time), then the streaming encoders 430 transmit the encoded signal

- 5 directly to the content storage devices 431. Similarly, if the incoming signal is already encoded in a particular streaming format, it may be transmitted directly to the content storage devices 431.

As new audio/video streaming content is added to the content storage devices 431, the SAM module 420 causes a storage database 430 to be updated

- 10 accordingly (e.g., via a content delivery subsystem). The storage database 430 in one embodiment is a distributed database which tracks all network content as it distributed and stored at various POP sites throughout the network.

As illustrated in **Figure 5**, the encoded signal is transmitted from the streaming origin servers 510 to streaming splitters 520-522, 530-532 located at a

- 15 various I-POP nodes 230-232 and E-POP nodes 240-242. Employing streaming splitters as illustrated conserves a substantial amount of network bandwidth.

For example, in the illustrated embodiment each streaming splitter 520-522, 530-532 receives only a single stream of live audio/video content from an upstream

server, which it then divides into several independent streams. This

- 20 configuration is particularly useful for streaming configurations which do not support multicasting.

Moreover, employing streaming splitters within a multi-tiered hierarchy, as illustrated in **Figure 5**, reduces bandwidth at each level in the hierarchy. For example, a single stream from a live streaming event may be transmitted from a streaming origin server 510 to an I-POP streaming splitter 521. The streaming 5 splitter 521 may then transmit a single stream to each of the E-POP streaming splitters 530-532, which may then transmit the live event to a plurality of end users 540-548. Accordingly, the network path between the data center 220 and the I-POP 231 is loaded with only a single stream and each of the three network paths between the I-POP 231 and the E-POPs 240-242 are loaded with only a 10 single stream. The incoming streams are then split at each of the E-POPs 240-242 to provide the live event to a plurality of end users 540-548.

#### *Fault Tolerant Stream Splitting*

As illustrated in **Figure 6**, one embodiment of the invention includes one or more root splitters 630 configured at POP sites 620 to receive a stream from an 15 origin server and distribute the stream to a plurality of leaf splitters 631-635. Each of the leaf splitters 631-635 serve a plurality of end users 650 by further splitting each stream received from the root splitter 630 into another plurality of end-user streams.

It can be seen from **Figure 6** that, for a particular live or scheduled 20 streaming event, the streaming encoder 530, the origin servers 510 and the root splitter 630 all represent single points of failure. In one embodiment, potential

failures at the data center 200 components (i.e., the origin server 510 and streaming encoder 530) are handled through allocation of redundant encoder/origin server pair combinations for each live/scheduled event.

However, in some circumstances, this level of redundancy may be impractical at

5 various POP sites 620 (e.g., due to limited media server resources at the site, limited and costly rack space, . . . etc). As such, in one embodiment, a more efficient mechanism may be implemented to provide fault tolerance at these POP sites 620.

As illustrated in **Figure 6**, in one embodiment, one or more of the leaf

10 splitters (e.g., leaf splitter 631) are configured as backups to the primary root splitter 630. In this embodiment, the health of the root splitter is continually monitored by a monitoring subsystem which may reside on the load balancer module 625, the redirection subsystem 625, or as a separate monitoring module and the data center and/or the POP site 620.

15 In one embodiment, the root splitter 630 is configured to provide an update to the monitoring subsystem at predetermined intervals. This may be accomplished by an agent 640 continually running on the root splitter 630 and configured to communicate with the monitoring subsystem. The periodic update in this embodiment acts as a “heartbeat” which indicates to the monitoring

20 subsystem that the root splitter is operating within normal parameters. If the monitoring subsystem does not receive an update for one or more periods, it

may determine that the root splitter has become inoperative and assign the backup root splitter 631 as the new primary root splitter. In one embodiment, the agent 641 running on the backup root splitter 631 performs the reconfiguration process. Alternatively, or in addition, the monitoring subsystem

- 5 may actively poll the agent 640 running on the root splitter 630 to verify that the root splitter 630 is operating reliably.

The operation of one embodiment of the system illustrated in **Figure 6** will now be described with respect to the flowchart in **Figure 7**. At 710, a user attempts to view a particular live or scheduled streaming event (e.g., such as a

- 10 Webcast). The user's request is received and processed by the redirection subsystem 610, which (at 715) directs the user to a particular POP site 620 from which the stream will be delivered (e.g., by returning a path directing the user's streaming application that POP site 620).

At 720, a load balancer module 625 residing at the POP site 620 selects a particular leaf splitter (e.g., splitter 633) from a group of leaf splitters 631-635 at the site. In one embodiment, the load balancer 625 is a layer 4 switch which continually monitors the load on each of the leaf splitters 631-635, and assigns the new user request to the least-loaded splitter. In this embodiment, the layer 4 switch may be identified by a virtual internet protocol ("VIP") address included

- 20 in the path sent by the redirection subsystem 610.

At 725, a root splitter failure is detected by the monitoring subsystem (e.g., via one or more of the failure detection techniques described above). As a result, the monitoring subsystem directs the backup root splitter 631 (e.g., via the backup agent 641) to reconfigure itself as the new primary root splitter 630. In 5 addition, the monitoring subsystem and/or the backup agent 641 directs the load balancer 625 to remove the backup root splitter 631 from the group of leaf splitters 631-635 monitored by the load balancer module 625.

It should be noted that the new primary root splitter 631, load balancer 625, leaf splitters 632-625, and/or redirection subsystem 610 may be reconfigured 10 differently following a root splitter 630 failure depending on the streaming formats supported by the system. When a user requests a file encoded in a RealPlayer® streaming format (e.g., through a RealPlayer application residing on the client computer) the redirection subsystem transmits a comprehensive path to the user, specifying the location of the streaming file and the servers through 15 which the data stream will pass on its way to the user. For example, a path such as “rtsp:\<VIP>\Split\<Root Server IP>\Split\ <Origin Server IP>\<Encoder IP>\live\_stream.rm” may be passed to the client’s streaming application, identifying the virtual IP address of the load balancer 625, the root splitter 630, the origin server 510, and the encoder 530 as well as the name of the actual 20 streaming file (“live\_stream.rm”). Accordingly, when the backup root server 631 is reconfigured as the primary root server 630 as described above, the path subsequently transmitted to users by the redirection subsystem 610 is updated to

reflect the new IP address of the root splitter in the <Root Server IP> field (i.e., the IP address of the former backup server 631).

By contrast, if the system is configured to support the Windows Media Technologies (“WMT”) streaming format, each server within the streaming path

- 5 may need to be updated following a root splitter 630 crash. More particularly, in this embodiment, WMT server “publishing points” are reconfigured beforehand on each server to point back to the upstream splitter 630, origin server 510, and/or encoder 530.

For example, following a user request for streaming content an exemplary

- 10 URL returned by the Redirection Subsystem 610 may look something like:

“mms://<VIP>/ <Broadcast Publishing Point(3)>.” Each edge splitter behind the VIP address would then expose “Broadcast Publishing Point(3)” and would thereby be configured to reference, for example, “<Root Splitter IP>/<Broadcast Publishing Point(2)>.” Continuing with this example, the WMT root splitter 630,

- 15 in turn, would expose “Broadcast Publishing Point(2)” which would be pre-configured to reference “<Origin Server IP>/<Broadcast Publishing Point(1)>.”

Finally, “Broadcast Publishing Point(1),” exposed by the WMT origin server 510 in one embodiment, would be filled with the stream received from the streaming encoder 530.

Thus, in this embodiment, when the monitoring subsystem detects a failure in the primary WMT root splitter 630, it must not only reconfigure the load balancer 625 to remove the backup root splitter 631 from the leaf splitter group, it must also reconfigure all the “Broadcast Publishing Point(3)” on the 5 remaining leaf splitters 632-635 so that they reference the new root splitter 631.

In addition, the new root splitter 631 must be reconfigured to remove its “Broadcast Publishing Point(3)” and now expose “Broadcast Publishing Point(2),” which points back to the origin server’s 510’s publishing point.

Accordingly, it can be seen that one of the benefits of the foregoing 10 configuration is that the Redirection Subsystem 610 can offer up the same URL to the user, even after the primary root splitter 630 fails. The user will then be provided the same stream using a newly-configured set of publishing points.

Regardless of which streaming format is used, new streams are provided to users through the new primary root splitter at 735. At 740, the operations staff 15 at the data center is notified of the primary root server failure. The operations staff may then attempt to evaluate and solve the problem remotely before making a trip to the POP site 620.

Embodiments of the present invention include various steps, which have been described above. The steps may be embodied in machine-executable 20 instructions. The instructions can be used to cause a general-purpose or special-

purpose processor to perform certain steps. Alternatively, these steps may be performed by specific hardware components that contain hardwired logic for performing the steps, or by any combination of programmed computer components and custom hardware components.

5 Elements of the invention may also be provided as a machine-readable medium for storing the machine-executable instructions. The machine-readable medium may include, but is not limited to, floppy diskettes, optical disks, CD-ROMs, and magneto-optical disks, ROMs, RAMs, EPROMs, EEPROMs, magnet or optical cards, propagation media or other type of media/machine-readable  
10 medium suitable for storing electronic instructions. For example, the present invention may be downloaded as a computer program which may be transferred from a remote computer (e.g., a server) to a requesting computer (e.g., a client) by way of data signals embodied in a carrier wave or other propagation medium via a communication link (e.g., a modem or network connection).

15 Throughout the foregoing description, for the purposes of explanation, numerous specific details were set forth in order to provide a thorough understanding of the invention. It will be apparent, however, to one skilled in the art that the invention may be practiced without some of these specific details. For example, although the foregoing embodiments were described in the context  
20 of specific streaming formats (e.g., Windows Media and RealMedia), various other streaming media formats may be implemented consistent with the

underlying principles of the invention. Accordingly, the scope and spirit of the invention should be judged in terms of the claims which follow.

## CLAIMS

What is claimed is:

1        1. A system comprising:  
2              a primary root splitter to split a data stream transmitted from an upstream  
3 server into a plurality of leaf splitter streams;  
4              a plurality of leaf splitters to split each of said leaf splitter streams into a  
5 plurality of end user streams, wherein one or more of said plurality of leaf  
6 splitters is a backup root splitter; and  
7              root splitter reassignment logic to reassign one of said backup root  
8 splitters as a new primary root splitter responsive to detecting a problem with  
9 said primary root splitter.

1  
1        2. The system as in claim 1 further comprising a load balancer module to  
2 direct client streaming requests to particular leaf splitters based on relative load  
3 on said leaf splitters.

1  
1        3. The system as in claim 1 further comprising a redirection subsystem  
2 to redirect client streaming requests to a particular point of presence site.

1  
1        4. The system as in claim 2 further comprising load balancer update  
2 logic for removing said backup leaf splitter from said plurality of leaf splitters to  
3 which said load balancer directs user streaming requests responsive to said  
4 backup root splitter being reassigned as a primary root splitter.

1  
1        5. The system as in claim 3 further comprising redirection subsystem  
2 update logic for notifying said redirection subsystem of said new primary root

3 splitter responsive to said backup splitter being reassigned as said new primary  
4 root splitter.

1

1       6. The system as in claim 5 wherein said redirection subsystem update  
2 logic transmits said new primary root splitter's IP address to said redirection  
3 subsystem.

1

1       7. The system as in claim 1 further comprising publish point update  
2 logic for updating publishing points within said system responsive to said  
3 backup root server being reassigned as said primary root server.

1

1       8. The system as in claim 1 further comprising monitoring logic for  
2 monitoring said primary root splitter to determine whether said root splitter is  
3 operating within normal parameters.

1

1       9. The system as in claim 8 wherein said monitoring logic receives a  
2 periodic heartbeat signal from said primary root splitter, and wherein not  
3 receiving said periodic heartbeat signal for one or more periods indicates a  
4 problem with said primary root splitter.

1

1       10. The system as in claim 8 wherein said monitoring logic transmits a  
2 monitor signal to said primary root splitter, and wherein not receiving a  
3 response from said root splitter indicates a problem with said primary root  
4 splitter.

1

1           11. A method comprising:

2           monitoring a primary root splitter to ensure that said primary root splitter  
3           is operating within predefined parameters, said primary root splitter to split a  
4           single data stream into multiple data streams transmitted to multiple leaf  
5           splitters; and

6           reassigning one of said leaf splitters as a new primary root splitter  
7           responsive to detecting that said primary root splitter is not operating within  
8           said predefined parameters.

1           12. The method of claim 11 further comprising:

2           updating a load balancer module to indicate that said leaf splitter is  
3           reassigned as a primary root splitter, said load balancer module for distributing  
4           user streaming requests to one or more of said leaf splitters based on load on  
5           each of said leaf splitters.

1           13. The method as in claim 11 further comprising:

2           updating a redirection subsystem to indicate that said leaf splitter is  
3           reassigned as a primary root splitter, said redirection subsystem for directing  
4           client streaming requests to a particular point of presence site.

1           14. The method of claim 13 further comprising:

2           updating a load balancer module at said point of presence site to indicate  
3           that said leaf splitter is reassigned as a new primary root splitter, said load  
4           balancer module for distributing user streaming requests to one or more of said  
5           leaf splitters at said point of presence site based on load on each of said leaf  
6           splitters.

1       15. The method as in claim 13 wherein updating said redirection  
2 subsystem comprises transmitting said new primary root splitter's IP address to  
3 said redirection subsystem.

1

1       16. The method as in claim 11 further comprising:  
2            updating one or more broadcast publish points to indicate said new  
3 primary root splitter.

1

1       17. A system comprising:  
2            a monitoring subsystem to detect whether a primary root splitter is  
3 operating under predetermined operational parameters; and  
4            root splitter reassignment logic to reassign a backup root splitter as a new  
5 primary root splitter responsive to detecting that said primary root splitter is  
6 operating outside of said predetermined operational parameters.

1

1       18. The system as in claim 17 wherein said backup root splitter is also a  
2 leaf splitter to receive a data stream from said primary root splitter and to split  
3 said data stream into a plurality of user streams when said primary root splitter  
4 is operating under said predetermined operational parameters.

1

1       19. The system as in claim 17 wherein said monitoring subsystem detects  
2 whether said primary root splitter is operating under predetermined operational  
3 parameters by periodically receiving a signal transmitted from said primary root  
4 splitter.

1

1           20. The system as in claim 17 further comprising load balancer logic for  
2 directing client streaming requests to said leaf splitter based on relative load of  
3 said leaf splitter in relation to one or more additional leaf splitters.

1

1           21. The system as in claim 20 further comprising a redirection subsystem  
2 to redirect client streaming requests to a particular point of presence site at  
3 which said load balancer and one or more of said leaf splitters reside.

1

1           22. An article of manufacture including a sequence of instructions which,  
2 when executed by a processor, cause said processor to:

3           monitor a primary root splitter to ensure that said primary root splitter is  
4 operating within predefined parameters, said primary root splitter to split a  
5 single data stream into multiple data streams transmitted to multiple leaf  
6 splitters; and

7           reassign one of said leaf splitters as a new primary root splitter responsive  
8 to detecting that said primary root splitter is not operating within said  
9 predefined parameters.

1

1           23. The article of manufacture as in claim 22 including additional  
2 instructions which, when executed by said processor, cause said processor to:

3           update a load balancer module to indicate that said leaf splitter is  
4 reassigned as a primary root splitter, said load balancer module for distributing  
5 user streaming requests to one or more of said leaf splitters based on load on  
6 each of said leaf splitters.

1

1        24. The article of manufacture as in claim 23 including additional  
2 instructions which, when executed by said processor, cause said processor to:  
3              update a redirection subsystem to indicate that said leaf splitter is  
4 reassigned as a primary root splitter, said redirection subsystem for directing  
5 client streaming requests to a particular point of presence site.

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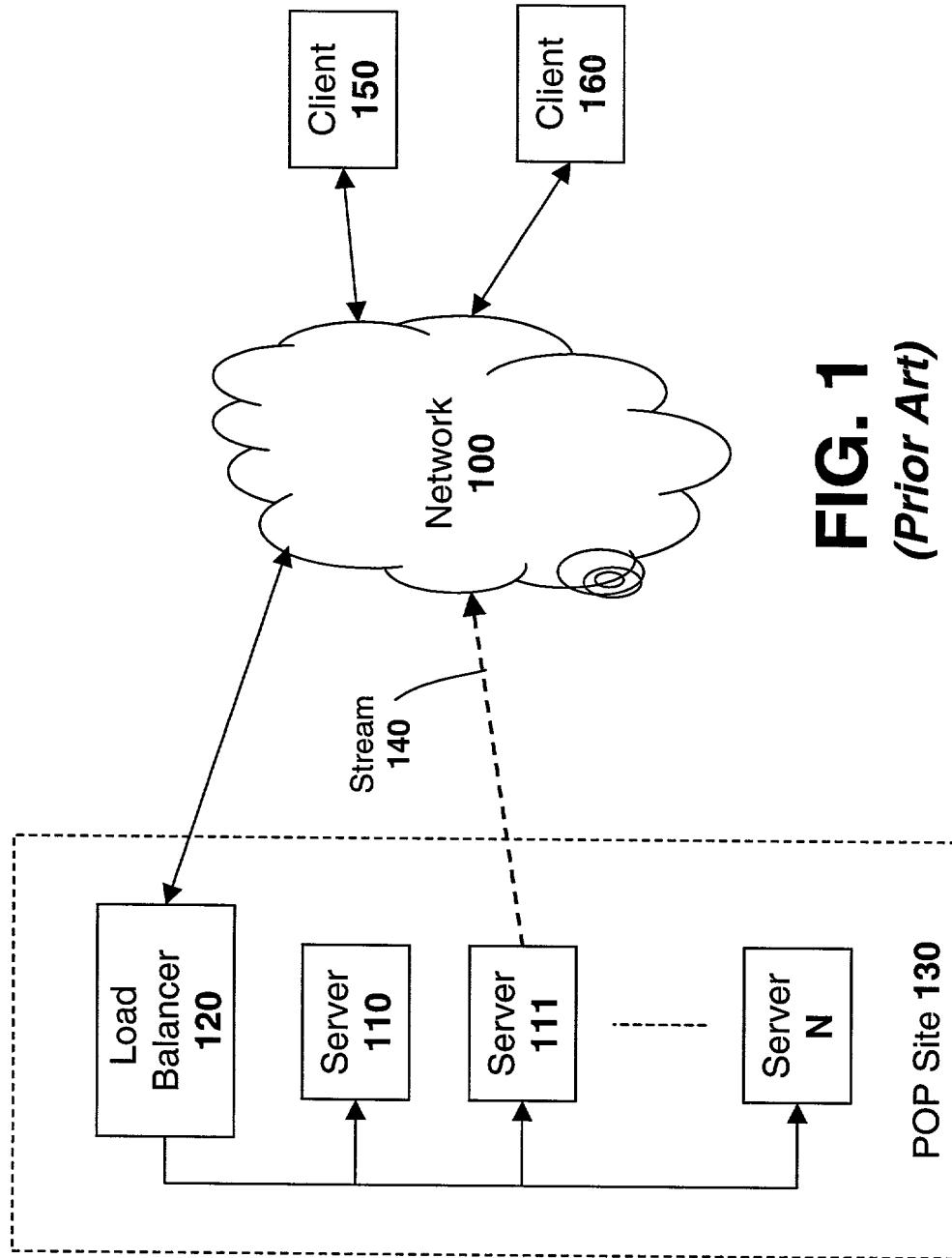
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## ABSTRACT

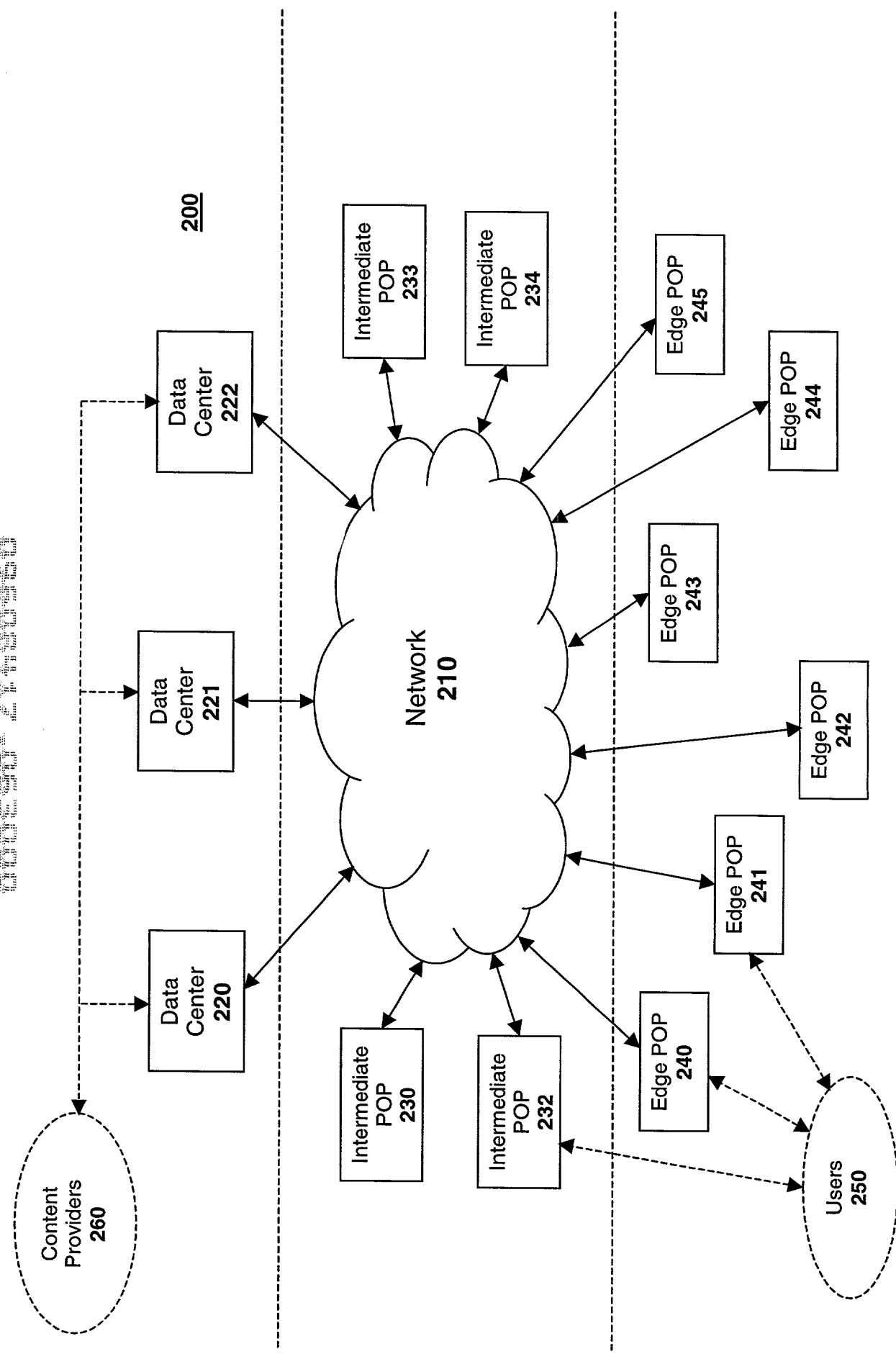
A system is described comprising: a primary root splitter to split a data stream transmitted from an upstream server into a plurality of leaf splitter streams; a plurality of leaf splitters to split each of the leaf splitter streams into a plurality of end user streams, wherein one or more of the plurality of leaf splitters is a backup root splitter; and root splitter reassignment logic for reassigning one of the backup root splitters as a new primary root splitter responsive to detecting a problem with the primary root splitter.

Also described is a method comprising: monitoring a primary root splitter to ensure that the primary root splitter is operating within predefined parameters, the primary root splitter to split a single data stream into multiple data streams transmitted to multiple leaf splitters; and reassigning one of the leaf splitters as a new primary root splitter responsive to detecting that the primary root splitter is not operating within the predefined parameters.

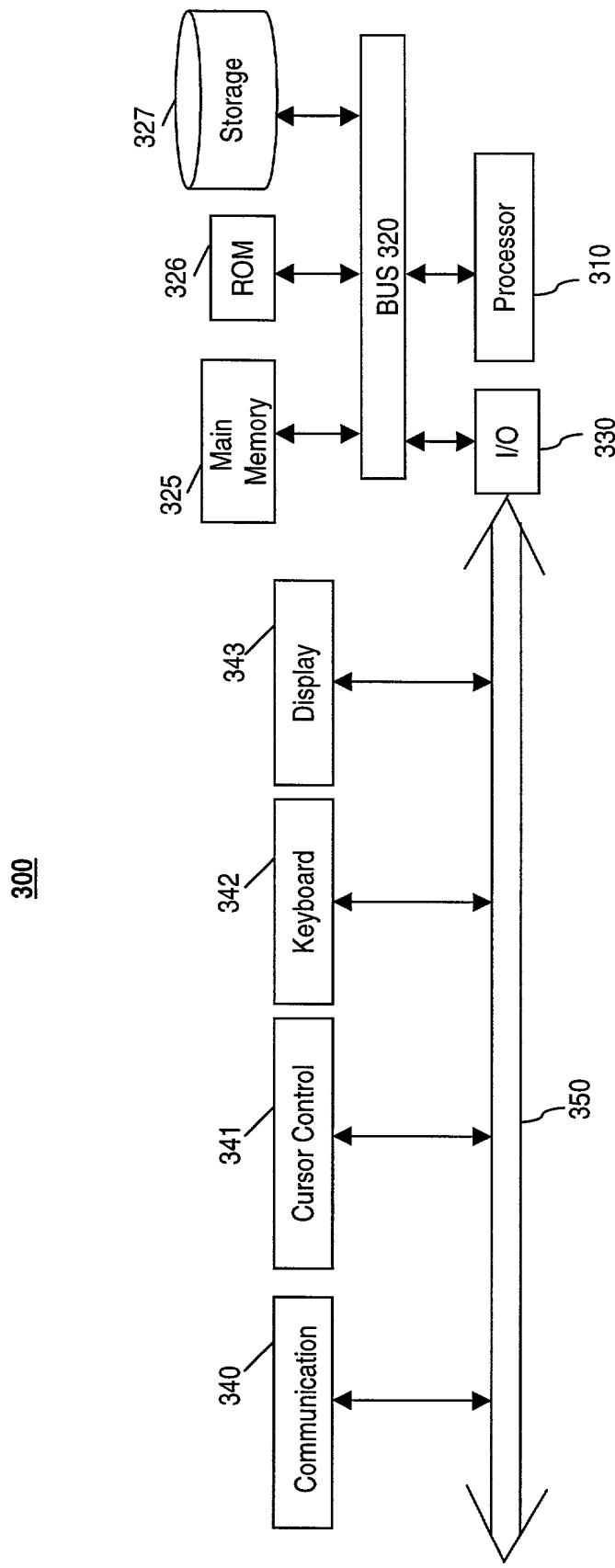


**FIG. 1**  
(*Prior Art*)

**FIG. 2**

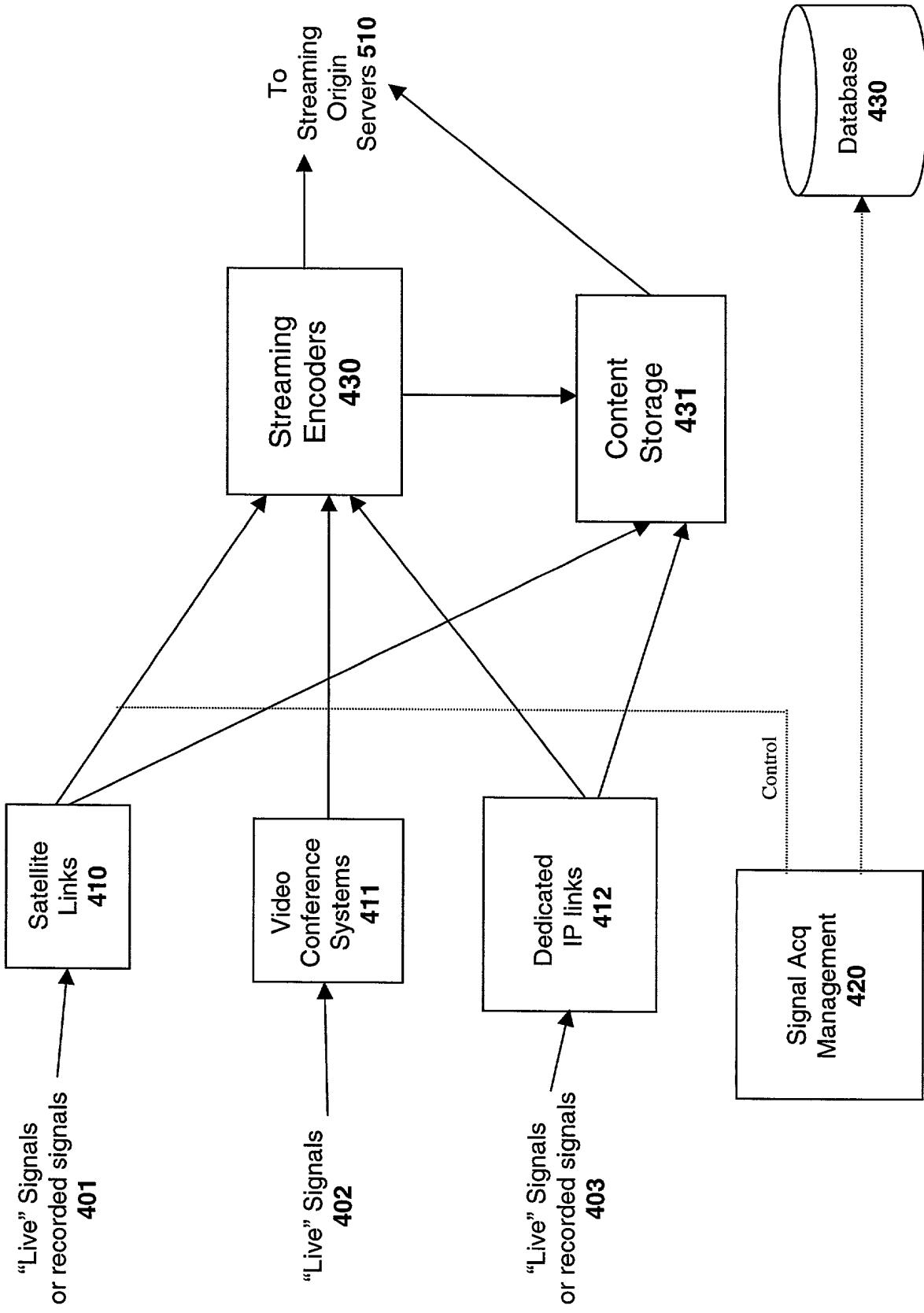


# FIG. 3



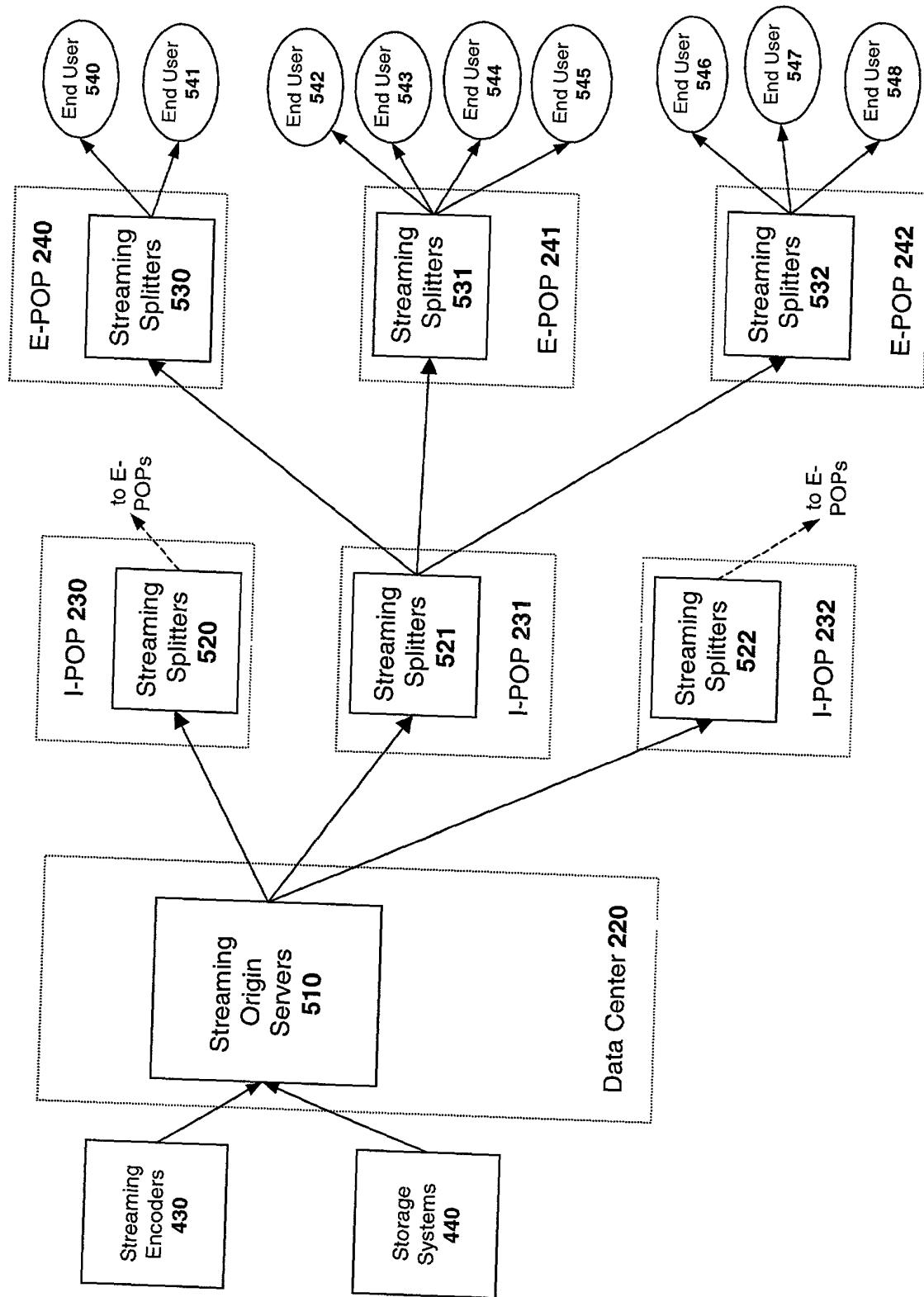
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**FIG. 4**

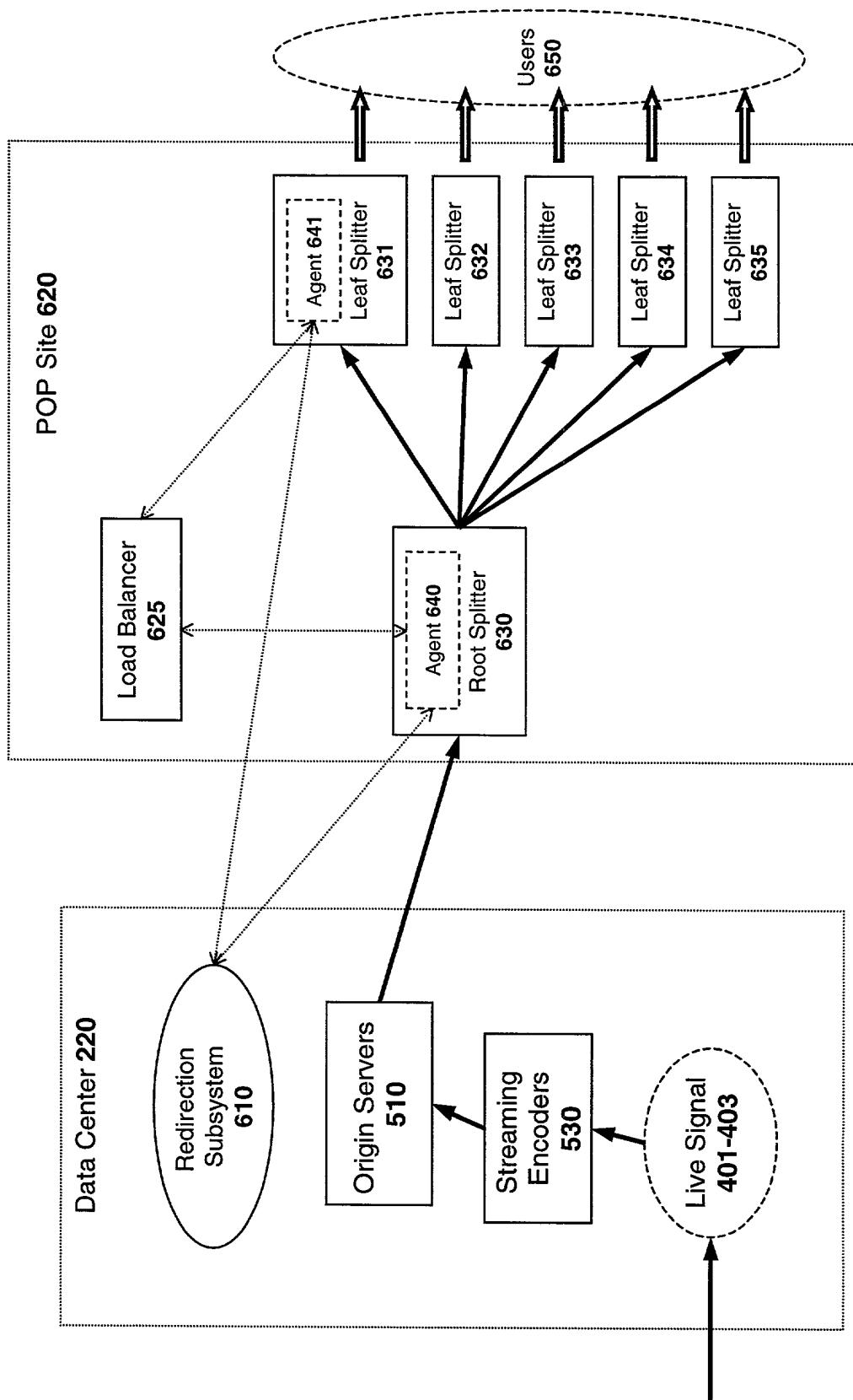


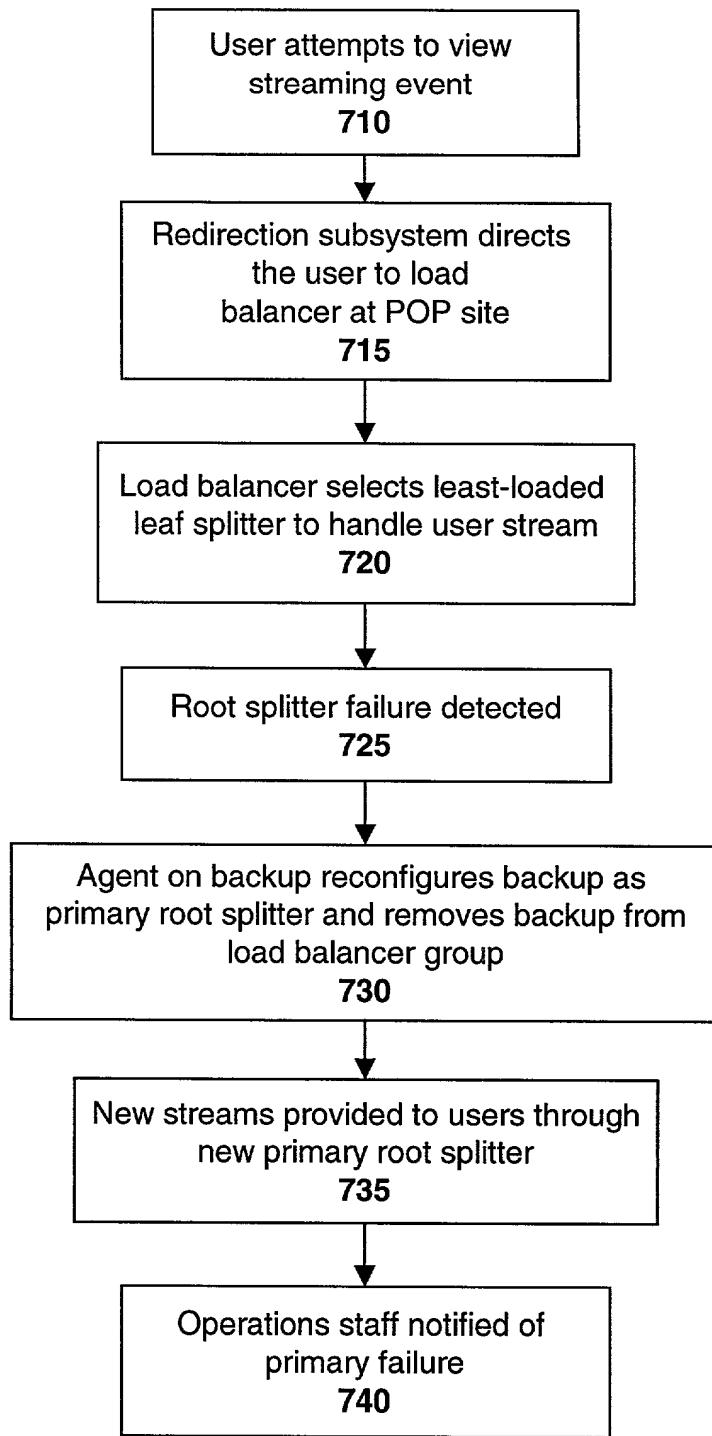
# FIG. 5

Diagram illustrating the network architecture for streaming delivery, showing the flow from Data Center 220 to various E-POPs and I-POPs.



# FIG. 6





**FIG. 7**

Attorney's Docket No.: 42390.P8795PATENT

**DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION**  
**(FOR INTEL CORPORATION PATENT APPLICATIONS)**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**System And Method For Fault Tolerant Stream Splitting**

the specification of which

X is attached hereto.  
— was filed on \_\_\_\_\_ as  
United States Application Number \_\_\_\_\_  
or PCT International Application Number \_\_\_\_\_  
and was amended on \_\_\_\_\_  
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above. I do not know and do not believe that the claimed invention was ever known or used in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, and that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (for a utility patent application) or six months (for a design patent application) prior to this application.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

<u>Prior Foreign Application(s)</u>	<u>Priority Claimed</u>
-------------------------------------	-----------------------------

(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below:

<u>Application Number</u>	<u>Filing Date</u>
<u>Application Number</u>	<u>Filing Date</u>

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

<u>Application Number</u>	<u>Filing Date</u>	<u>Status -- patented, pending, abandoned</u>
<u>Application Number</u>	<u>Filing Date</u>	<u>Status -- patented, pending, abandoned</u>

I hereby appoint the persons listed on Appendix A hereto (which is incorporated by reference and a part of this document) as my respective patent attorneys and patent agents, with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

Send correspondence to Thomas C. Webster, BLAKELY, SOKOLOFF, TAYLOR & (Name of Attorney or Agent)  
ZAFMAN LLP, 12400 Wilshire Boulevard 7th Floor, Los Angeles, California 90025 and direct telephone calls to Thomas C. Webster, (408) 720-8300.  
(Name of Attorney or Agent)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Inventor's Signature Reed J. Sloss Date June 29, 2000

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Inventor's Signature \_\_\_\_\_ Date \_\_\_\_\_

Residence \_\_\_\_\_ Citizenship \_\_\_\_\_  
(City, State) (Country)

Post Office Address \_\_\_\_\_

Full Name of Third/Joint Inventor \_\_\_\_\_

Inventor's Signature \_\_\_\_\_ Date \_\_\_\_\_

Residence \_\_\_\_\_ Citizenship \_\_\_\_\_  
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Post Office Address \_\_\_\_\_

APPENDIX A

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APPENDIX BTitle 37, Code of Federal Regulations, Section 1.56  
Duty to Disclose Information Material to Patentability

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclosure information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclosure all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

- (1) Prior art cited in search reports of a foreign patent office in a counterpart application, and
  - (2) The closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.
- (b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made or record in the application, and
- (1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or
  - (2) It refutes, or is inconsistent with, a position the applicant takes in:
    - (i) Opposing an argument of unpatentability relied on by the Office, or
    - (ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

- (1) Each inventor named in the application;
- (2) Each attorney or agent who prepares or prosecutes the application; and
- (3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.